



U.S. Department of Energy  
Energy Efficiency and Renewable Energy

# Program Overview: Update on Program Progress

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US Department of Energy

Office of Energy Efficiency and Renewable Energy  
Buildings Technologies Program

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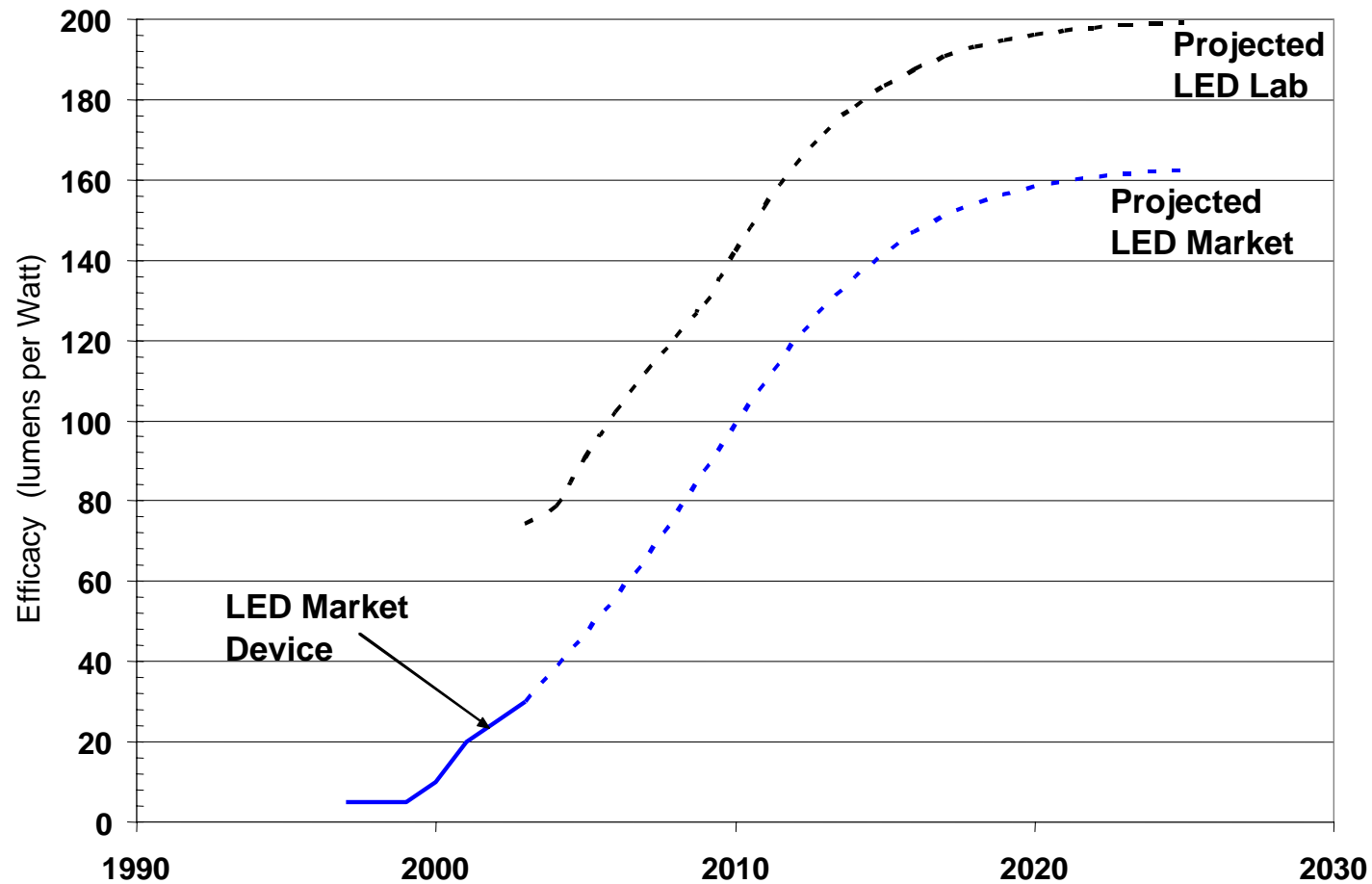
# Mission Statement

## **Solid-State Lighting Program Mission**

**Guided by a government-industry partnership, the mission is to create a new market for high-efficiency, general illumination products through the advancement of semiconductor technologies, to save energy and enhance the quality of the lighted environment.**

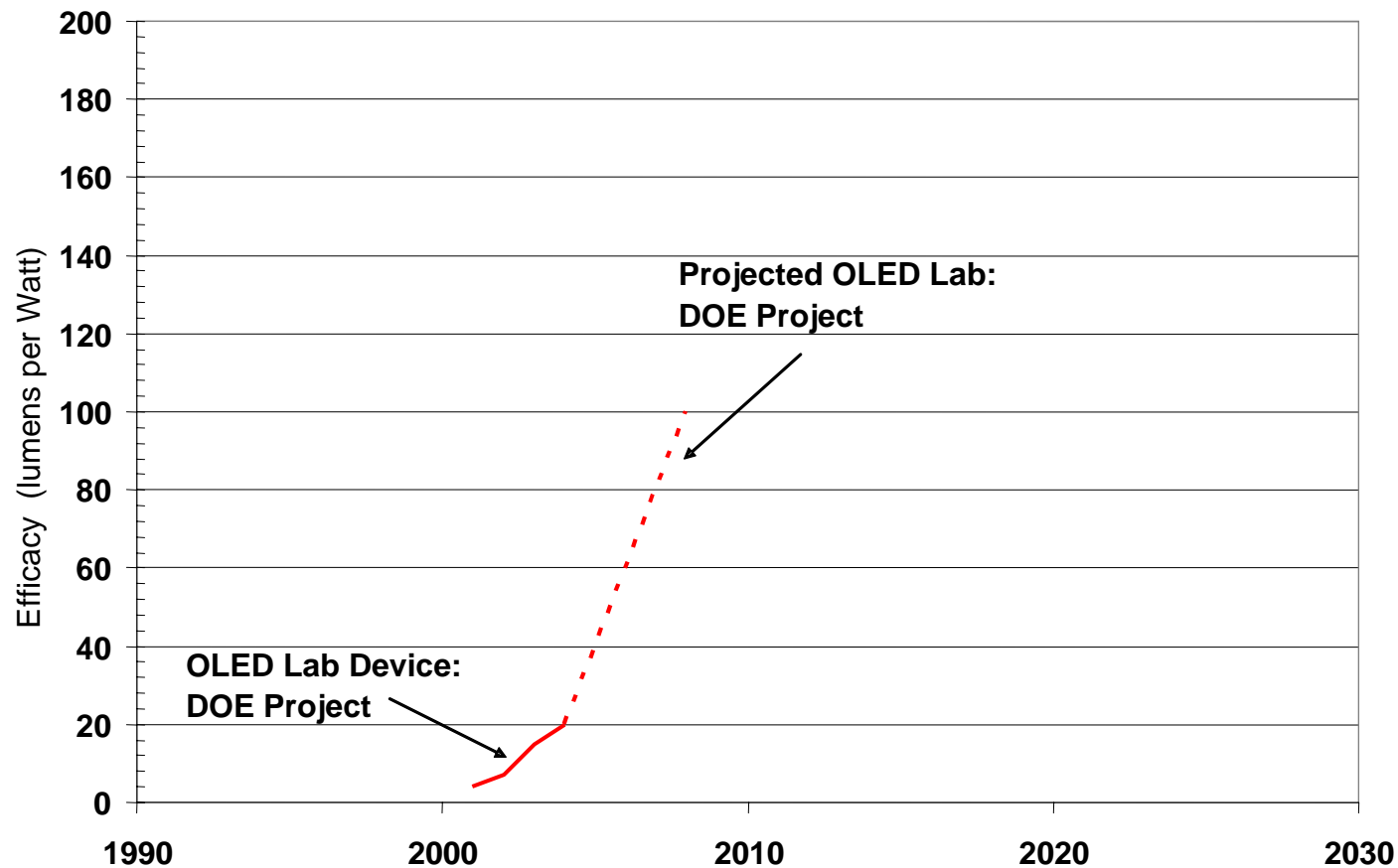


# White-Light LED Efficacy Targets





# White-Light OLED Efficacy Targets





# The Legislative Authority

## Domenici-Barton Energy Policy Act 2005

### Section 912

*“The Secretary shall carry out a Next Generation Lighting Initiative in accordance with this section to support research, development, demonstration, and commercial application activities related to advanced solid-state lighting technologies based on white light emitting diodes.”*



## Next Generation Lighting Initiative Key Points

- Authorizes \$50 million for FY2007 through FY 2013
- Competitively select Industry Alliance
- Award competitive R&D projects
- Directs for intellectual property guidance - an Exceptional Circumstance Determination
- Make roadmaps and general information available to public

- [www.netl.doe.gov/ssl](http://www.netl.doe.gov/ssl)



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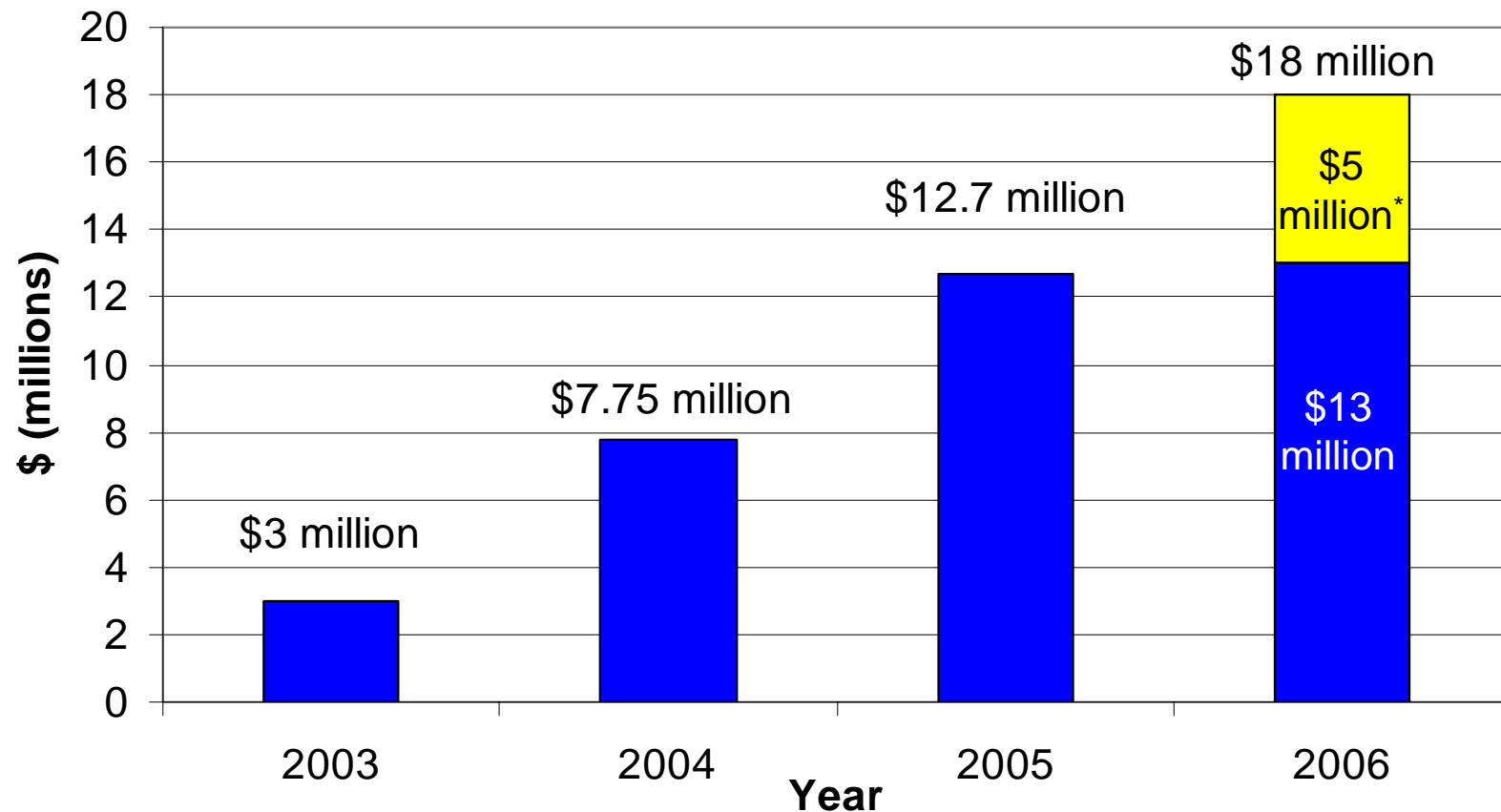
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Program Progress and Management





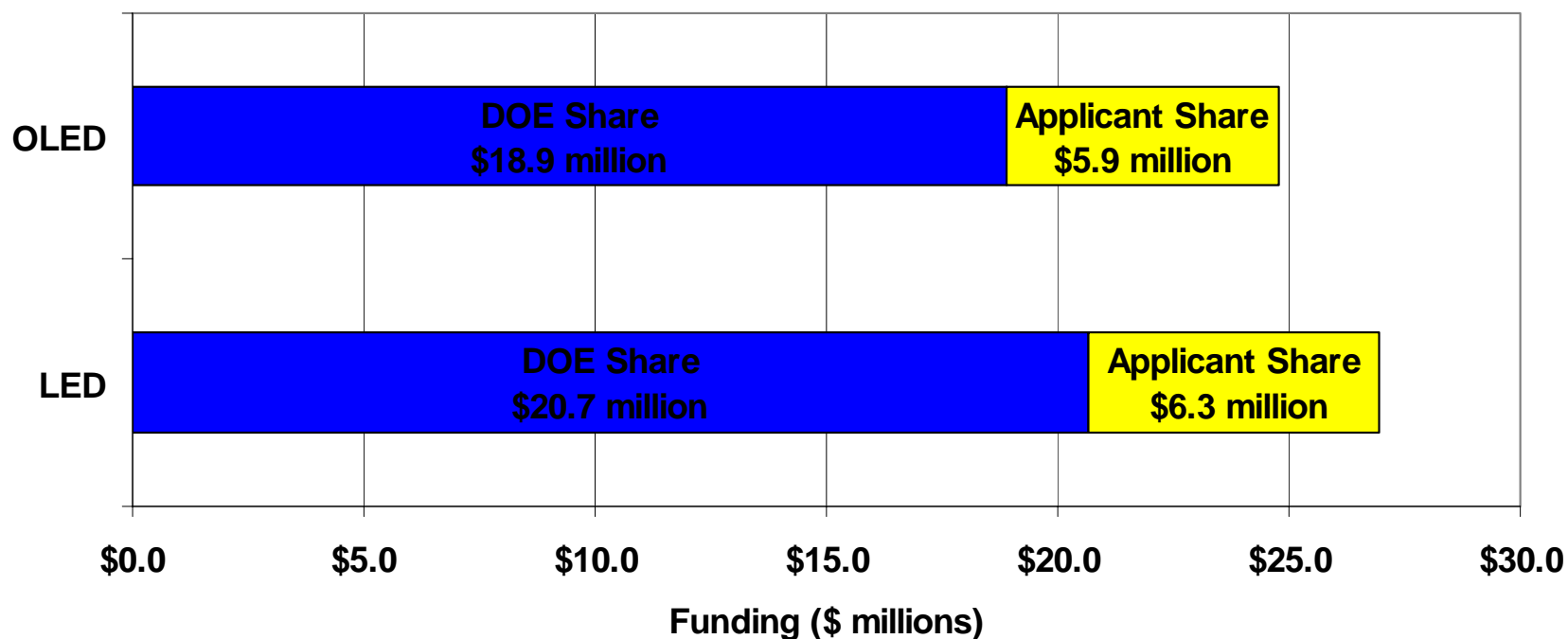
## Congressional Appropriation (\$ million)



\* Congressional Directive



## SSL R&D Project Funding



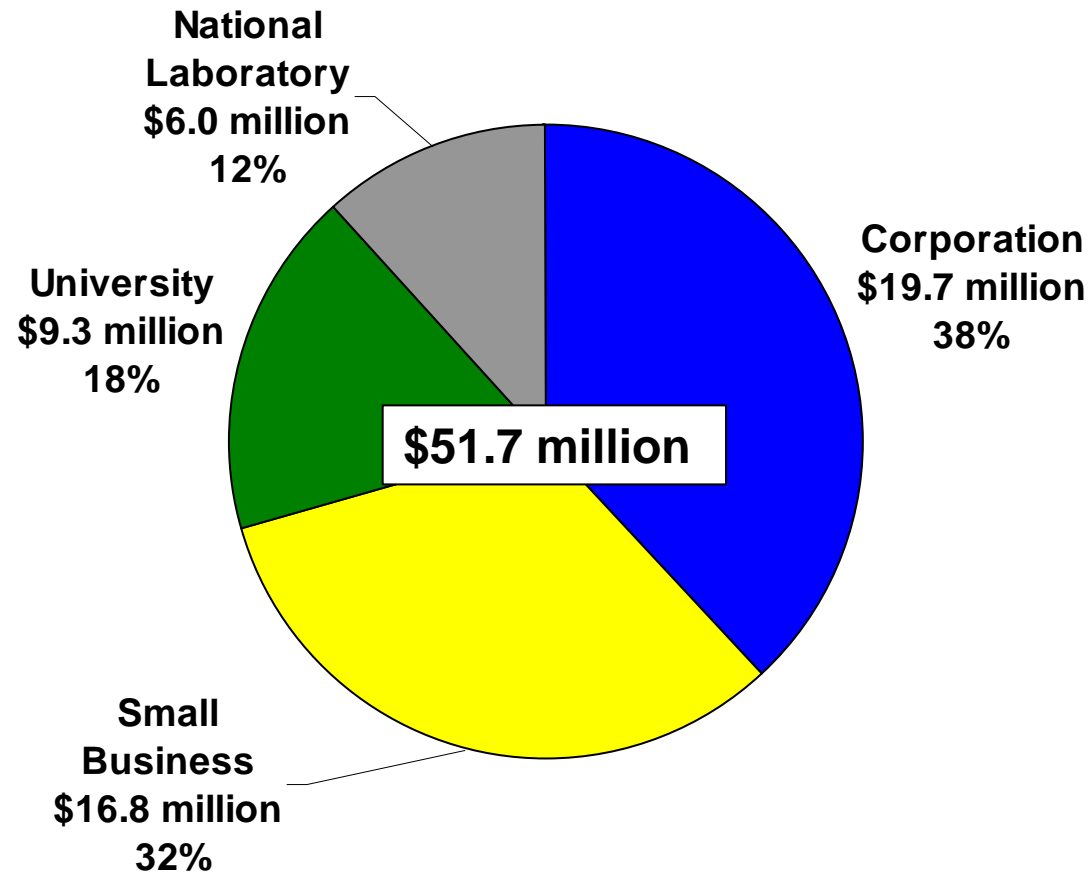
Total Contract Value of Projects: \$51.7 million\* (35 projects)

- OLED: \$24.8 million (14 projects)
- LED: \$26.9 million (21 projects)

\* The total contract value includes DOE funding (\$39.6 million) and applicant cost-share (\$12.2 million)



## Recipients of DOE Funding



- The Department funds solid-state lighting research in partnership with industry, universities, and national labs.



## Total Portfolio: Core Technology

	Total # of Projects	\$ Funding (million)
<b>Light Emitting Diode</b>		
High-efficiency semiconductor materials	8	\$10.1
Device approaches, structures and systems	4	\$3.1
Phosphors and conversion materials	5	\$5.5
<b>Organic Light Emitting Diode</b>		
High-efficiency, low-voltage stable materials	8	\$9.7
Low-cost encapsulation and packaging	3	\$5.5
Research on low-cost transparent electrodes	1	\$0.8
<b>Total</b>	<b>29</b>	<b>\$34.7</b>

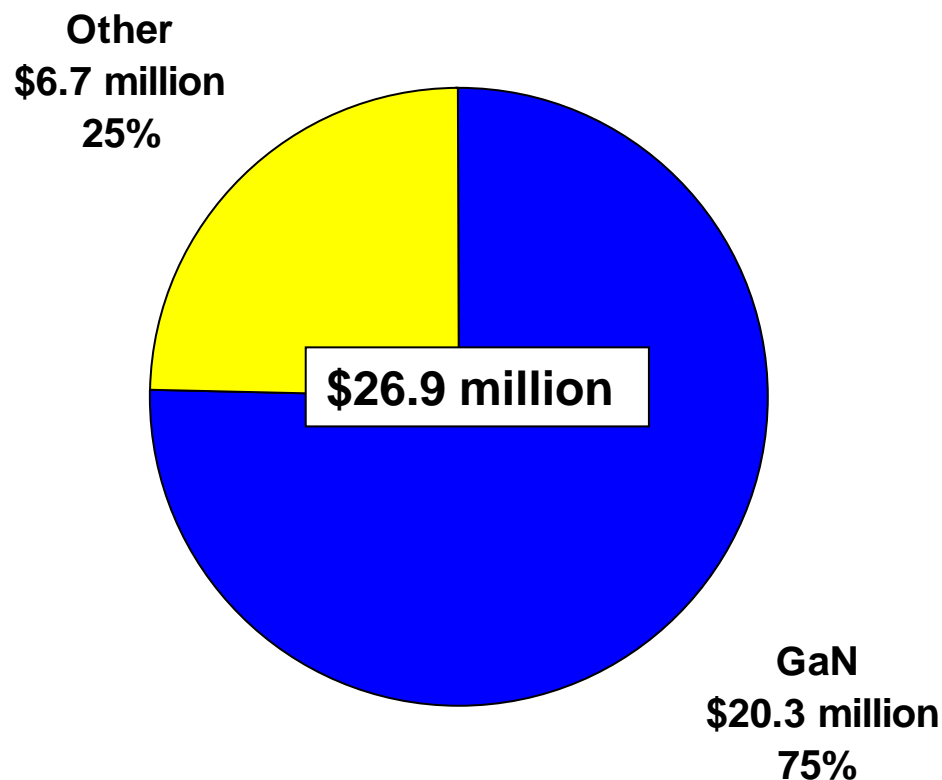


## Total Portfolio: Product Development

	Total # of Projects	\$ Funding (million)
<b>Light Emitting Diode</b>		
Manufactured Materials	0	\$0.0
Optical Coupling and Modeling	4	\$8.2
<b>Organic Light Emitting Diode</b>		
Between electrodes high-efficiency, low-voltage stable materials	1	\$4.1
Develop architectures that improve device robustness, increase lifetime and increase efficiency	1	\$4.8
<b>Total</b>	<b>6</b>	<b>\$17.1</b>



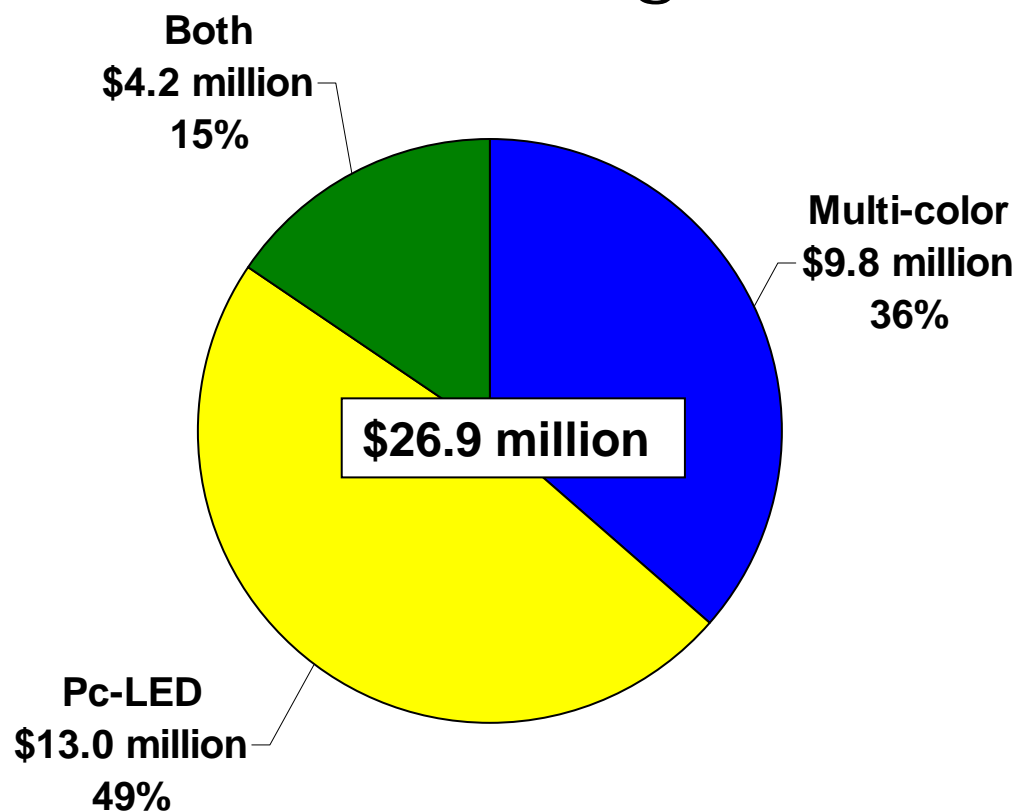
# Compound Semiconductor Materials Systems



- Of the 21 LED projects, 17 involve research with Gallium Nitride (GaN) materials systems, and 4 involve work with other material systems.



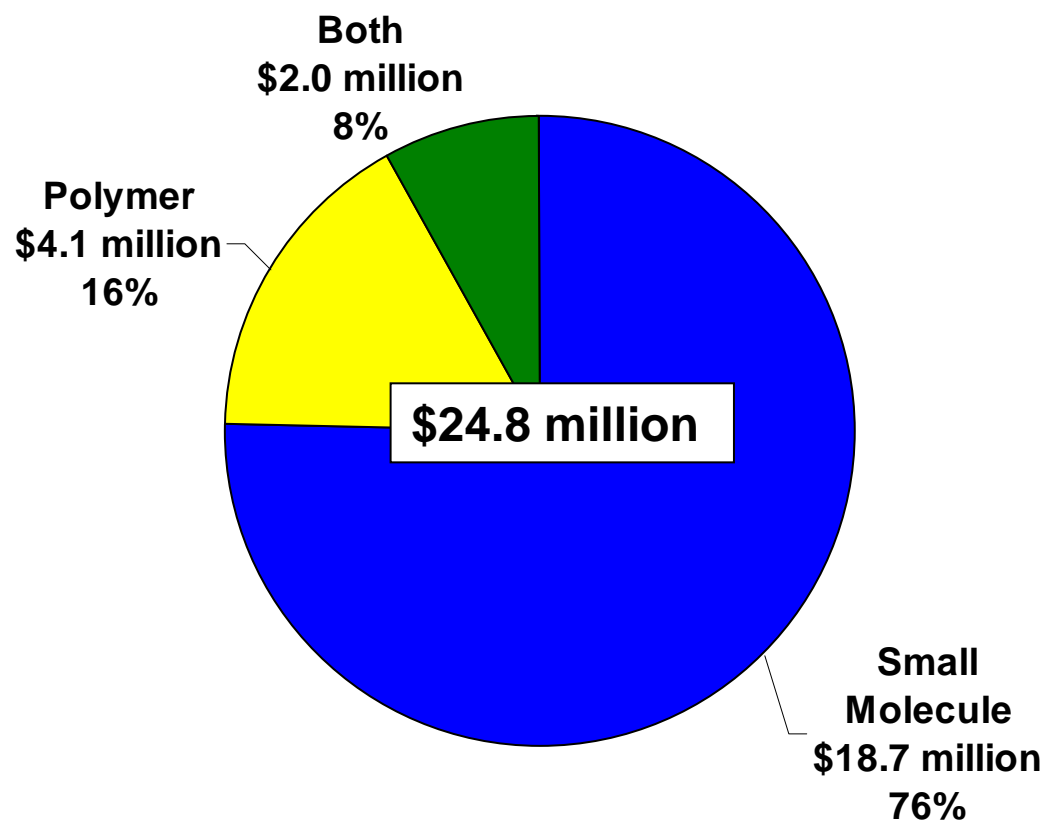
## Methods for Creating White Light



- Of the 21 LED projects, 4 are studying multi-color systems, 11 are researching pcLED systems, and 6 are studying technologies that could apply to either method of creating white light.



## OLED Material Systems



- Of the 14 OLED projects, 12 projects are researching small molecule OLEDs, one is researching polymer OLEDs and one could apply to either OLED material system.





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## Cree Lighting Project Meets DOE FY05 Joule Target

- White LED device efficacy of 65 LPW
- Novel chip design balanced with multiple interrelated design parameters
- Pre-production prototype uses standard XLamp™ package





## OSRAM Demonstrates OLED Success

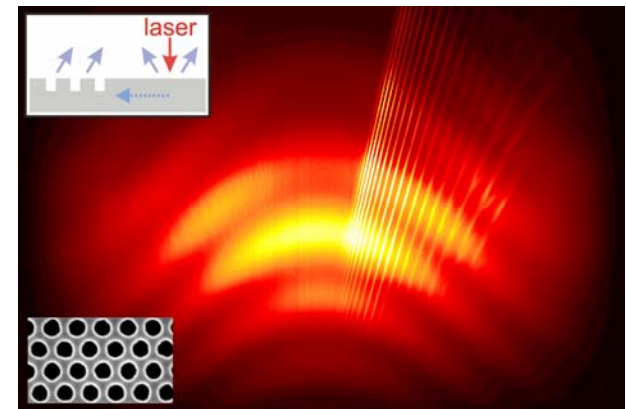
- Polymer-based white OLED
- Achieves record efficiency of 25 LPW
- Combines orange inorganic phosphor with record-setting blue-light device





## University of California at Santa Barbara Advances LED Chip Design

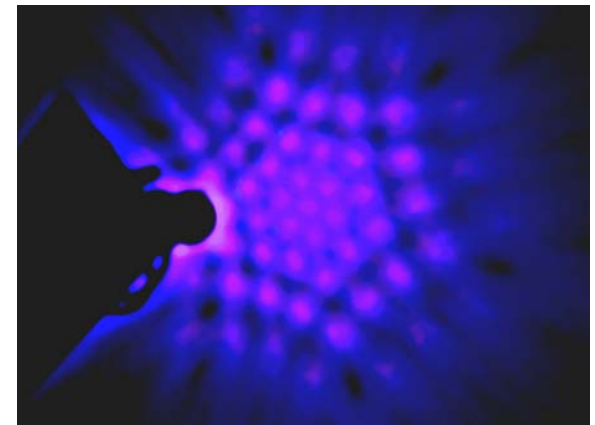
- Altered chip geometry to increase light output
- Achieved photonic crystal effects in GaN
- Demonstrated micro-cavity LEDs in InGaN





# Lumileds, University of New Mexico, Sandia National Laboratories Demonstrate Largest-Area Photonic Crystal LED

- Large-area devices key to:
  - Assisting in verifying extraction efficiency gains
  - Enabling systematic optimization of parameters
  - Allowing exposure of edge effects
- Important step toward low-cost, high-volume manufacturing of photonic crystal LEDs



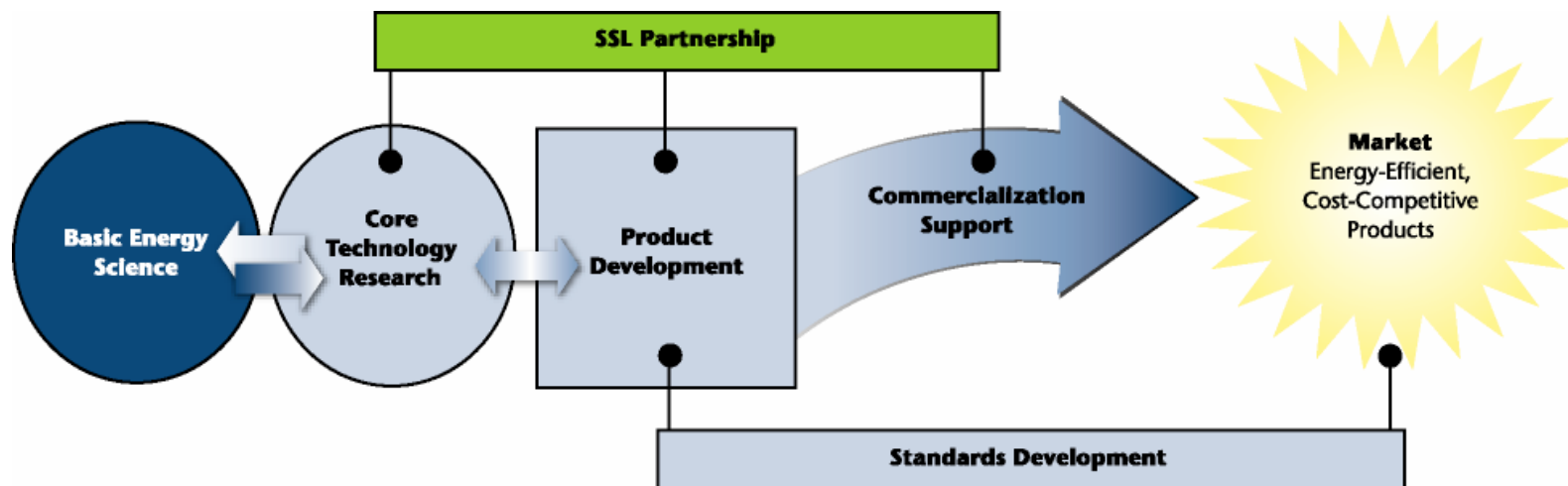


## Rensselaer Develops Silicone-based LED Encapsulant

- Has functional properties of traditional encapsulants
- Resists yellowing up to 140°C in UV light
  - Traditional encapsulant epoxies yellow due to oxidation or exposure to UV light
- Licensed by Rohm and Haas, who will support further research, market introduction



## DOE Solid-State Lighting 5 Thrust – Total Program



Guiding technology advances from  
laboratory to marketplace



# Stage Gate R&D Management

	<b>Basic Science Research 1</b>	<b>Applied Research 2</b>	<b>Exploratory Development 3</b>	<b>Advanced Development 4</b>	<b>Engineering Development 5</b>	<b>Product Demonstration 6</b>	<b>Commercialize and Sales 7</b>
<b>Technical Activities</b>	<i>Knowledge Base Expansion</i>	<i>Idea Generation</i>	<i>Proof of Technology- Product Definition</i>	<i>Proof of Technology- Working Model</i>	<i>Engineering Prototype</i>	<i>Production Prototype</i>	<i>Utilization by End User</i>
<b>Gate Expectations</b>	<div>1</div> <i>New Concept Proven</i>	<div>2</div> <i>Technical proof Performance</i>	<div>3</div> <i>Advantages over existing</i>	<div>4</div> <i>Consumer payback Market demand</i>	<div>5</div> <i>Market criteria</i>	<div>6</div> <i>Production ready</i>	
<b>Deliverables Required for Gate Decisions</b>	<i>Paper or journal article  Document proof of concept</i>	<i>Empirical performance evidence  Building end- use energy</i>	<i>Compare to baseline  Preliminary market assessment</i>	<i>Specifications  Detailed market assessment  Issues and benefits</i>	<i>Partnership agreements  Field tested  Cost/benefit analysis</i>	<i>Final product specification  National energy savings potential</i>	